GLAST Large Area Telescope Science Program & Collaboration Organization

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Introduction

- Hardware responsibilities are clear: organization chart for management of hardware / flight software follows from recognition of these responsibilities

- Collaboration science program organized around key science themes and 3 key projects
  - Need to clarify scientific roles and responsibilities of co-investigators, associate scientists, graduate students, post-docs;
  - Need collaboration publication policy (technical and scientific);
  - Need policy for how new collaboration members are added

Collaboration Science Program

- Science Program specified in flight proposal response to AO – proposal is for science investigation, not just for instrument
- GLAST is a facility to be utilized by the scientific community – Guest Observer program a vital part of GLAST mission
- NASA AO specifies data policy; mostly consistent with data policy recommended by GLAST Facility Science Definition Team
  - Team responsible for 1st year all-sky survey;
  - Transients released "immediately";
  - Team could propose for specific sources (exclusive rights to data on broad classes of sources not allowed), and we did;
  - Team can propose observations for subsequent years as part of GLAST Guest Observer program (similar to CGRO);
  - Team is responsible for Instrument Operations; overlap with GLAST Science Center and Mission Ops to be clarified during Formulation Phase

Key Science Themes

Large FOV (2.4 sr) with calorimetry & low bkgrnd.	Energy range to > 300 GeV with < 10% spectral res.	Fine angular resolution (0.39° @ 1 GeV)	Low instrument dead time (20 μs)	Bkgrnd. Rejection 2.5 x 10^5:1 with high γ efficiency	**Science Themes**	Formation of structure in the early universe	Extreme Environments	Nature of dark matter	Exchange of energy & matter between stars & ISM
✓	✓	✓		✓	**Particle Acceleration in AGNs, Pulsars & SNRs**		✓		✓
✓		✓		✓	**Resolve the γ-ray sky**		✓		✓
	✓		✓		**High-energy behavior of GRBs and transients**	✓	✓		
✓	✓	✓	✓	✓	**Galactic dark matter and the early universe**	✓		✓	

GLAST LAT Strengths

NASA OSS Goals

GLAST LAT Science Team Key Projects

- All-Sky Survey: Catalog
- Gamma-ray Bursts & Transients: GRB Catalog and On-line alert
- In-depth Analysis of Selected Sources

Data Products from LAT Team Projects

Table 2.1.4: All-Sky Survey Project

Data Product	Updates	Comments
Source Catalog	Available and regularly updated on the web, with major publications after 1, 2, and 5 years	Includes significance, flux, spectra, locations, and identifications
All-Sky Map	1, 2, and 5 years	Intensity, counts, and exposure maps over various energy ranges
Residual Maps	1, 2, and 5 years	A residual map for each all-sky map after subtracting point sources and Galactic emission
Diffuse Model	Prelaunch, then update as necessary	

Table 2.1.5: GRB and Transients Project

Data Product	Updates	Comments
GRB Catalog	Monthly via WWW, with periodic refereed publications	Includes fluence, durations, time profiles, spectra, and locations
Transient Alerts	Continuous, on a timescale of days via WWW and IAU circulars for transients. Continuous, on a timescale of seconds for GRBs and via GCN.	GRBs and other transient alerts will include flux and locations. Flaring sources will include possible identifications

In-depth Analyses of Selected Sources

Table 2.1.6: Selected Sources for In-depth Analyses

Sources	Characteristics	Science Goals
PARTICLE ACCELERATION in PULSARS and PLERIONS		
PSR 1951+32	EGRET pulsar, 39.5 ms, 100 kyr, 2.5 kpc, $B=10^{12}$ G,	Study phase-resolved spectra and test LAT absolute timing data and software; measure the cut-off energy E_{cut} above 10 GeV to extend the $E_{cut}(B)$ relation; spatially resolve its remnant CTB80 (∅=80')
PSR 1617-5055	Radio pulsar not seen by EGRET despite its 8th rank in E/D^2, 69 ms, 8 kyr, 6.5 kpc	Deeply search for pulsed emission to constrain the beaming fraction in γ rays vs. polar cap and outer gap predictions; search for DC emission from its remnant RCW103 (∅= 10')
PSR1853+01 plerion	267 ms, 20 kyr, 3.3 kpc, $B=2\ 10^{13}$ G, high E/D^2, in 3EG1856+0114 error box	Study DC emission from the X-ray/radio plerion; search for pulsed emission to extend the Ecut(B) relation to high field; spatially resolve the outer shell (Ω44: ∅ ~ 30')
COSMIC-RAY ACCELERATION in SUPERNOVA REMNANTS		
Cas A Kepler	SN II in ~1670, 2.8 kpc, ∅= 5' SN Ib in 1604, 4.4 kpc, ∅= 3'	Study young shocks in SN II and SN Ib environments: radio to TeV data to separate electron and nuclei emission; long-term monitoring to look for a compact star; higher density for Cas A & increased LAT sensitivity at b = 6.8° for Kepler
Cygnus Loop IC443	Sedov phase, 360 pc, 230'x160' Sedov phase, 1-2 kpc, ∅= 45', in 3EG 0617+2238 error box	Later SNR stage: spatially and spectrally resolve the nuclei emission; study non-linear acceleration; low Galactic background (b=8.5°) for Cyg Loop; enhanced nuclei emissivity expected where IC443 overtakes an H_2 cloud and X-ray and radio spectra harden
RX0852.0-4622 "Vela, Jr."	680 yr, ∅= 2.1°, closest SNR to Earth, 4.4° away from intense Vela pulsar	Observe using photons from Vela off-pulse time intervals to test source searches and localization in the wings of intense neighbors
NEARBY GALAXIES		
M31 LMC SMC	670 kpc, ∅~ 3° 55 kpc, ∅~ 8° 63 kpc, ∅~ 3°	Spatially and spectrally resolve their interstellar γ radiation to study cosmic rays, magnetic fields; compare energy balance and mass tracers in different metallicity environments
A 1656 Coma cluster	z = 0.02, ∅~ 1°	Constrain the energy density of cosmic rays inside a cluster; resolve the predicted emission above a low background (b= 89°); study the merging of two clusters
ACTIVE GALACTIC NUCLEI		
PKS0528+134 Mrk 501	EGRET flat spectrum quasar, z = 2.06 TeV BL Lac, z = 0.03	Multi-wavelength, multiyear monitoring to explore particle acceleration in blazar jets, in particular γ-ray spectral evolution from quiescent to flaring states
Cen A	Radio galaxy, z = 0.002, 3EG1324-4314	Confirm EGRET detection and study γ-ray emission from AGN jets at large viewing angles (>70°)
UNIDENTIFIED SOURCE REGIONS		
Rabbit region: l= 313° ±1° b= 0° ±1° Ω region: l= 17.5° ±1.6° b= -0.75°± 0.75°	3EG1420-6038 and 3EG1410-6147 3EG1826-1302 and 3EG1824-1514	Identify the γ-ray sources in complex regions and test source confusion limits; Rabbit: 2 SNRs, 1 candidate pulsar, 1 candidate plerion, and a few non-thermal shells Ω: 2 SNRs, PSR1823-13 (high E/D^2), and PSR1822-14
Galactic Center	l = 0° ±1°, b = 0° ±1° 3EG1746-285	Multi-year monitoring of the high-energy activity around SagA* and g-ray source localization with respect to the giant H2 clouds and to AXAF, XMM, and INTEGRAL sources
3EG1835+59	Brightest high-latitude, unid source, $E^{-1.7}$ spectrum	Search for a radio-quiet pulsar, test periodicity search software
GALACTIC SOURCES WITH RELATIVISTIC JETS		
GRS1915+105	Micro-quasar, 12.5 kpc jet velocity = 0.9.c	Search for predicted γ-ray emission from relativistic jets at large angles and compare to AGN emission; multi-year monitoring for flaring activity
SS433	5 kpc jet velocity = 0.3.c	Study termination shocks from jets impacting the remnant shell (120'x60') and producing non-thermal X-rays

Sources selected to:

- initiate team's science program;
- best evaluate instrument performance;
- improve all aspects of LAT data analysis & software, benefiting entire community

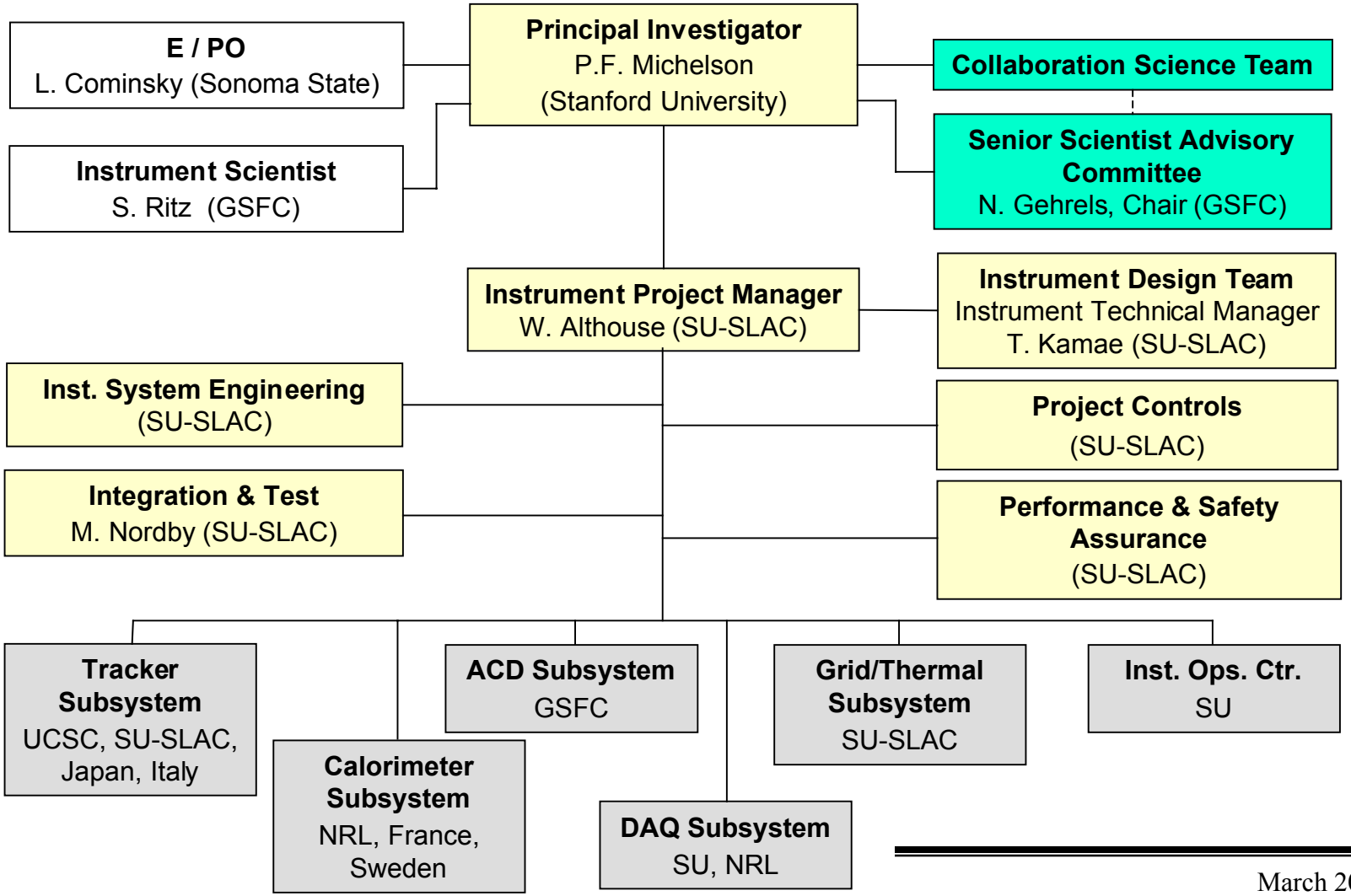
Analysis will:

- use all-sky survey data and multiwavelength campaigns where applicable;
- take advantage of team's expertise, particularly in modelling the structured Galactic background to resolve extended sources

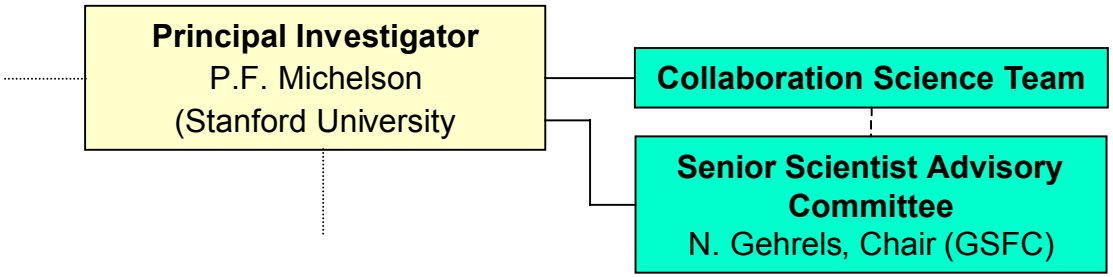
Collaboration Organizational Issues

GLAST LAT Organization Chart

- Organization Chart reflects institutional responsibilities for hardware, software, instrument management, science investigation



Collaboration Science Team Organization



• Current **Collaboration Science Team** consists of Co-Investigators and Associate Scientists named in flight proposal: 41 Co-Investigators, 34 Associate Scientists

• **Data Responsibilities (and Rights) and Team's Key Projects** established by the GLAST Facility Science Definition Team, AO 99-OSS-03, and the accepted Flight Investigation proposal

• **Senior Scientist Advisory Committee (SSAC):** advisory to Principal Investigator on scientific matters and will assist/advise in the scientific organization of the collaboration. Membership consists of sub-group of co-investigators named in proposal

Co-Investigators

Prof. Isabelle Grenier	CEA-Saclay	Dr. Eric Grove	NRL
Dr. Philippe Goret		Dr. W. Neil Johnson	
Dr. Jacques Paul		Dr. Michael Lovellette	
Dr. Arache Djannati-Atai	IN2P3 (College de France)	Dr. Kent S. Wood	
		Dr. Bernard F. Phlips	NRL/George Mason U.
Dr. Patrick Fleury	IN2P3 (Ecole Polytechnique)		
		Dr. Ying-Chi Lin	SU-HEPL
Dr. Tierry Reposeur	IN2P3 (Bordeaux)	Dr. Patrick L. Nolan	
		Dr. Scott D. Williams	
Dr. Neil Gehrels	GSFC	Dr. P. Roger Williamson	
Dr. Alexander A. Moiseev		Prof. Elliott D. Bloom	SU-SLAC
Dr. Jay Norris		Dr. Richard Dubois	
Dr. Jonathan F. Ormes		Dr. Gary L. Godfrey	
Dr. Steven Ritz		Prof. Tuneyoshi Kamae	
Dr. David J. Thompson		Dr. James J. Russell	
Dr. Seth W. Digel	GSFC/USRA	Dr. Roland Svensson	Stockholm Obs.
Prof. Takashi Ohsugi	Hiroshima U.	Prof. Lynn R. Cominsky	Sonoma State U.
Dr. Patrizia Caraveo	IFC, CNR	Dr. Daniel J. Suson	Texas A&M U.
Dr. Aldo Morselli	INFN (Roma II)	Prof. Tadashi Kifune	UCRR, U. Tokyo
Prof. Guido Barbiellini	INFN (Trieste)	Prof. Robert Johnson	UCSC
Dr. Tadayuki Takahashi	ISAS	Prof. Hartmut Sadrozinski	
Prof. Per Carlson	KTH-Stockholm	Prof. Terry Schalk	
		Prof. Thompson H. Burnett	U. of Washington

Co-Investigators:

- named in flight proposal and confirmed by NASA Associate Administrator upon acceptance of proposal,

- have identified hardware or software responsibility or identified organizational responsibility for some key aspect of proposed science program,

- major time commitment implied ($\tilde{>}$50%)

Associate Scientists

Dr. John Mattox	Boston U.	Dr. Annalisa Celotti	Int. SchoolAdv.St.
Prof. Marc Kamionkowski	Caltech	Dr. Masanobu Ozaki	ISAS
Dr. Ann Wehrle		Dr. Tom Francke	KTH-Stockholm
Dr. F. Lebrun	CEA-Saclay	Dr. H. Mayer-Hasselwander	MPE
Dr. J. P. Dezalay	CESR Toulouse	Dr. Gottfried Kanbach	
Prof. Rene A. Ong	U. Chicago	Dr. Andrew Strong	
Prof. Mark Oreglia		Dr. Jeffrey D. Scargle	NASA Ames
Prof. G. Pelletier	U. Grenoble	Dr. Charles D. Dermer	NRL
Dr. J. T. Bonnell	GSFC	Prof. Vahe Petrosian	Stanford U.
Dr. Alice K. Harding		Prof. Roger Romani	
Dr. Stanley D. Hunter		Dr. E. do Couto e Silva	SU-SLAC
Dr. Floyd W. Stecker		Dr. Paul Kunz	
Dr. Matthew G. Baring	GSFC/USRA	Prof. Lars Bergstrom	Stockholm U.
Dr. Katsuichi Yoshida	Hiroshima U.	Dr. Yasushi Fukazawa	U. Tokyo
Prof. Ryoji Enomoto	ICRR, U. Tokyo	Prof. Joel R. Primack	UCSC
Prof. Masaki Mori		Prof. Stanford E. Woosley	
Dr. Piergiorgio Picozza	INFN	Prof. Brenda Dingus	U. Wisconsin

Associate Scientists:

- named in flight proposal; additional Assoc. Sci. can be added with advice of SSAC;

- if at Co-I institution, participation in science analysis negotiated with lead Co-I and PI; otherwise negotiated with PI on advice of SSAC;

- time commitment implied usually less than 50%;

- typically will participate in specific science areas as part of Co-I led team

Senior Scientist Advisory Committee

advisory to Principal Investigator on scientific matters and will assist/advise in the scientific organization of the collaboration.

Guido Barbiellini
Elliott Bloom
Thompson Burnett
Per Carlson
Richard Dubois
Patrick Fleury
Neil Gehrels, chair
Isabelle Grenier
W. Neil Johnson
Robert Johnson
Tuneyoshi Kamae
Jonathan Ormes
Steve Ritz
Hartmut Sadrozinski
David Thompson
Roger Williamson
Kent Wood

GLAST Science Working Group (SWG) Members from LAT Team

- AO specified that Instrument PI plus up to 6 Co-Investigators (3 supported by NASA plus 3 additional Co-I's that are leads of foreign collaborating teams) can be designated members of SWG

Guido Barbiellini	Peter Michelson
Elliott Bloom	Tuneyoshi Kamae
Isabelle Grenier	W. Neil Johnson
	David Thompson

Other members of the SWG, appointed by NASA, are the Project Scientist (Chair of SWG), 4 Interdisciplinary Scientists (IDS), and Secondary Instrument PI. (IDS: Charles Dermer, Brenda Dingus, Martin Pohl, Steve Thorsett,)

Issues

- Several issues face us regarding how we are organized scientifically. Some of these are:
  - Publication policy
  - Graduate student thesis topics
  - Etc.
- Publication Policy must acknowledge contributions of collaborators to instrument, to infrastructure required to support data analysis, and should encourage contribution of original scientific ideas
  - A possible approach: initial publications relatively inclusive (i.e., long author lists), transitioning to shorter author lists as analysis becomes more in-depth on particular topics; will ask SSAC to consider publication policy;
  - Must find means to insure that younger scientists (graduate students and postdocs) have opportunity to demonstrate scientific independence;
  - To assist PI and SSAC in organizing scientific analysis effort, ask each Co-I and Associate Scientist to prepare a brief (2 page) "mini-proposal" or statement of his/her primary scientific interest(s) and proposed approach, schedule, etc..


We've only got a few years left before we have to launch; let's get to work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Slave Driver!